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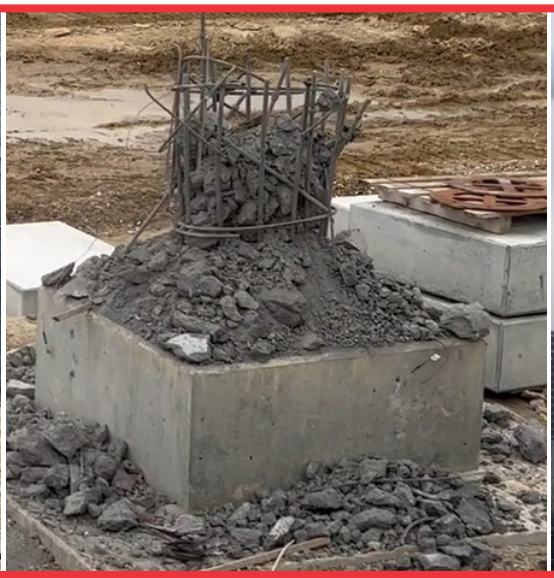
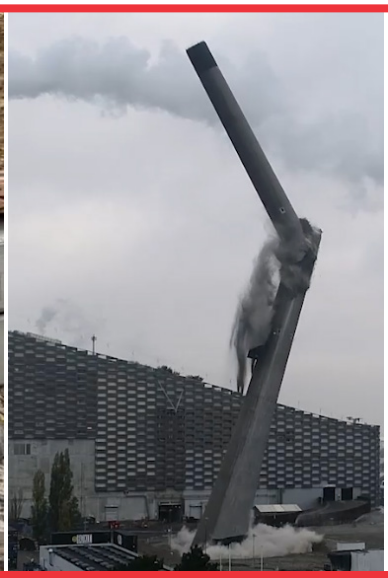




Safety instructions in blasting work

DSF-Instruction no. 3
December 2024

Preface

This instruction has been prepared by the Danish Federation of Explosives Engineers (DSF) for use by DSF members.

Applicable legislation in Denmark and Greenland takes precedence over the DSF instruction.

The instruction is 8 revised editions and replaces the Industry Guide on Safety in Blasting Work published by the Industry Working Environment Council for Building & Construction (ISBN 87-7952-021-9).

OK Finn Linnemann has provided safety distances for underwater blasting.

Stated instructions and guidelines are for guidance only and do not relieve the individual user of responsibility in connection with specific work performed.

The Danish Federation of Explosives Engineers assumes no responsibility for the consequences of any specific blasting work.

The recommendation was approved at the board meeting in December 2024.

Jakob Schneider	Kim Thomas Poulsen	Mikkel Lerdrup
Poul-Rikard Ebbesen	Jørgen Schneider *Chairman*	Johan Finsteen Gjødvad

Safety instructions in blasting work

Content

Safety instructions in blasting work

1. Purpose, scope, and basis of the instruction

1.1 The purpose of this instruction is to ensure maximum safety when blasting operations are carried out.

1.2 Blasting work can be, for example, blasting of:

- Rock blasting, e.g., bench blasting, trench blasting, dimensional stone blasting, contour blasting, tunnelling, mining, construction work, etc.
- Concrete foundations and other concrete structures, total or partial, mini blasting, piling piles, etc.
- Slag in furnaces, filters, boilers, and silos.
- Boulder, wood, iron/steel, ice, permafrost, earth, etc.

1.3 The instruction is intended for blasting work in the construction industry and in the raw materials industry as well as for other uses of explosives (explosives and igniters), e.g., seismic blasting, explosion forming, ammunition clearance, experiments, and development, etc.

2. References

Reference is generally made to laws, provisions, etc., concerning the handling, transport, and use of explosives, etc., as well as matters relating to health and safety. See also Annex I.

3. General instructions

3.1 The acquisition, use, and handling of explosives in Denmark requires permission from the Police Administrative Center (PAC). The permit can only be granted to persons who can prove the necessary professional expertise by documenting training in explosive techniques approved by the Danish National Police.

3.2 Blasting work must always be planned and carried out in such a way as to prevent damage of any kind.

3.3 Blasting work includes the following:

- Planning
- Drilling
- Charging
- Drilling and simultaneous charging
- Handling of explosives, incl. storage and transport
- Safety measures including covering, sealing off, and possible evacuation
- Firing and returning to the blasting area
- Destruction of explosives.

In addition, there are other processes related to blasting work, including seeding and order at the blast site, clean-up after the blast, etc.

3.4 Companies carrying out blasting operations must always appoint a shotfirer, who is personally responsible to the authorities for:

- The transport and storage of explosives
- Obtaining the necessary permits
- The safety at work with regard to the blasting operations referred to in section 3.3.

3.5 The company is responsible for ensuring that the shotfirer has everything necessary to conduct the blasting, including:

- Drawings and descriptions of the detonation object
- Installations in the ground and near the detonation object
- Agreements with affected persons and companies
- Other information of importance for the safety and environment.

3.6 The harmful effects and nuisances of blasting are typically the following:

- Explosion fragments
- Pressure waves in air and water
- Heat exposure (which may cause fires)
- Vibrations
- Dust
- Noise.

3.7 Particular attention should be paid to the risk of damage caused by:

- Accidental explosion or fire due to heat or mechanical sources, improper use of explosives and equipment, e.g. drilling into non-detonated explosives from previous blasts
- Inhalation of detonation gases or smoke
- Falling or damaged equipment and material as a result of blasting operations
- Handling of explosives and inhalation of fumes (allergy or respiratory damage).

Please refer to DSF instruction no. 6: Safety Control in Blasting Work.

Further details of blast injuries to persons and first aid in the event of explosion accidents can be found on www.explosives.dk.

3.8 Smoking and open flames in or near areas where explosives are stored or used are strictly prohibited.

3.9 The risk of dust explosion must be assessed. The risk of dust explosion is present when blasting organic materials or when blasting materials with high organic content. Pyrite can occur in certain rocks and the vapours can ignite when the explosive ignites. The possibility of spontaneous ignition of the vapours cannot be ruled out. The risk of ignition can be reduced by dousing with water. When the content of pyrite is high (above 30%), it is important that the area is evacuated and that the ignition takes place above ground

or from a specially secured area underground and at a safe distance from the blast site. The use of emulsion explosives may reduce the risk of the vapours igniting.

3.10 At the access road(s) to the danger zone, signs must indicate that blasting work is taking place.

3.11 The danger zone, which is the area within which explosion fragments may occur (see section 14), must be lit – artificially if necessary.

4. Shotfirer

4.1 The shotfirer is responsible for:

- The blasting work being carried out professionally and correctly, taking into account the particular risks associated with blasting in the given environment
- A written detonation plan being prepared (see the Danish Federation of Explosives Engineers' instruction no. 5 and Annex 1 of the Danish Work Environment Authority's provision on the layout of construction sites) and that deviations are regularly noted down
- The transport, storage, and handling of explosives being carried out in accordance with the regulations
- A blasting permission being obtained from the local police
- Permission from the natural gas supplier being obtained when blasting within areas with property regulations in accordance with the natural gas suppliers' regulations.

5. Seeding and order at the blast site

5.1 Soil and materials on top of the detonation object must be removed so the blasting area can be clearly seen and the drilling can be carried out safely.

5.2 If blasting has taken place in the area previously, the seeding of soil and materials must be so effective that the surface is clean and can be seen, so you do not drill into previous blasting holes.

5.3 After blasting, the shotfirer must check that all explosives have detonated. If there is uncertainty that all explosives have been detonated, the materials must be checked during clearing and handling.

5.4 If simultaneous drilling and charging are to be carried out, see section 8 below.

6. Drilling

6.1 Drilling in old blasting holes is **prohibited**.

6.2 Out of consideration for the work environment, dust development during drilling must be limited by wet drilling or the establishment of extraction.

6.3 The boreholes in the two front rows of holes in a bench blasting above ground must be checked for borehole deviation if the bench height exceeds 10 metres.

7. Charging

7.1 Charging must be carried out so the risk of accidental ignition is avoided. Charging must not be carried out when there is thunder and lightning in the area. When there is a risk of thunder and lightning, the weather forecast should be monitored closely (APP for smartphones can be recommended) and electric detonators should not be used.

7.2 In the event of thunder and lightning, work is immediately suspended and the danger zone is evacuated.

7.3 If boreholes are to be charged for more than one working day, low-energy electric detonators or electronic detonators must not be used.

7.4 If the charging work is carried out over several working days, one or more of the following safeguards against unauthorised access to the blast site must be arranged:

- Guard with physical presence at the blast site
- Effective locking of the blast site, which prevents unauthorized persons from accessing the charged blast holes
- Video surveillance with an on-call guard.

7.5 When charging with gunpowder, the ramrod must be made of wood and without fittings. It is important that the ramrod and charging tube are of a suitable size in relation to the borehole so electrical wires, signal conductors, or detonating cords are not damaged during charging. Fittings on ramrods for gunpowder can cause sparking or frictional heat, which can ignite the gunpowder.

7.6 When charging with other explosives, the ramrod and charging weight must be made of wood, bamboo, anti-static plastic, non-sparking metal, or similar materials. For example, the tip of the ramrod can be made of copper. And the fittings can be made of copper or brass.

7.7 The charging tube must be made so ignition does not occur during charging as a result of electrostatic charging. When charging with powder explosives and emulsion explosives, the charging tube must have a resistance of 1–30 kΩ/m. The tube must be clearly marked with the type and dimension of the tube and the type of charging for which it is intended.

7.8 For the manufacture and charging of explosives at energy delivery points, only devices suitable for the task and of recognised type and make must be used. The equipment must be approved by the authorities prior to use.

7.9 Blowpipes must be made of non-sparking material such as copper, brass, plastic, or the like. Blowpipes of steel or other similar material must not be used.

7.10 Packing gunpowder must be carried out with caution so as not to risk sudden ignition due to friction, heat, sparks, etc.

8. Charging and simultaneous drilling

8.1 Charging and simultaneous drilling should be avoided at a distance corresponding to the minimum depth of the hole, the breadth of the drilling rig, and the length of the drill bit.

8.2 Where it is necessary to carry out drilling and charging work at the same time, e.g. when surface water may run down into the frozen soil and mountain and under similarly difficult conditions, it is the responsibility of the shotfirer to ensure that:

- The number of people present be kept to a minimum
- All drillers and blast people on site know the drilling plan
- The drilling plan is followed strictly
- The distance between charging and drilling of nearby holes does not risk the drilling into the charging
- The workplace is well lit.

8.3 The Swedish Spränganvisningar[1] stipulates that the distance between drilling and charging must be at least as shown in Table 1.

Table 1: Safety distance between charging work and boreholes.

Length of borehole, H_b	Minimum hole distance
$H_b \leq 6$ metres	2 metres
6 m $< H_b \leq 12$ metres	3 metres
12 m $< H_b \leq 16$ metres	4 metres
16 m $< H_b \leq 20$ metres	5 metres

[1] Arbetarskyddsstyrelsen, 1985, mars (omtryckta), *Spränganvisningar. Anvisningar angående skydd mot yrkesfara vid sprängningsarbete*. Arbetarskyddsstyrelsen. ISBN 91-38-02967-7.

If explosives in cartridges are used and there is no risk of explosives getting into cracks and crevices, and when only shallow holes and smaller hole diametres have been drilled in concrete, the following can be recommended:

Length of borehole, Hb, charged or to be charged	Minimum distance
$H_b \leq 2$ metres	The depth of the hole
2 metres $< H_b \leq 6$ metres	2 metres

8.4 Drilling with a drilling rig should always be carried out in such a way as to avoid bending drill rods. Shallow holes, rigid drill rods, and new step drill bits should be used. It should be noted that the holes may differ due to bent drill bits, skewed sharpening of step drill bits, or great tension/pressure on the drill rods.

8.5 Drilling should be carried out with a mobile drilling rig, which has the appropriate equipment to control the positioning and slope, and the drilling plan can be better followed. The positioning and slope must be carried out carefully.

8.6 Particular attention should be paid when drilling is carried out with a mobile drilling rig that does not provide the ability to control the position and slope.

8.7 Under no circumstances must the mobile drilling rig sit on top of boreholes that are charged but must stand perpendicular to the boreholes. The drilling personnel must be positioned so the drilling rig tower and the drill protect against any explosion fragments from the part that is charged.

8.8 Similarly, if drilling is carried out with hand-operated equipment, attention should be paid as described in sections 8.4–8.7.

9. Explosives and detonators in general

9.1 Only explosives and detonators of recognized type and make may be used for blasting operations. The manufacturer's/supplier's instructions must always be followed.

9.2 Special consideration shall be given to detonators and ignition systems described below:

- Safety fuse and detonator no. 8
- Electric detonators
- Shock-tube detonators
- Electronic detonators.

A description of the safety conditions can be found in sections 10–13.

10. Safety fuse

10.1 Safety fuses with or without detonator no. 8 attached via heat shrinking must only be used when it is possible to prevent anyone from entering the danger zone between the time of ignition and the detonation. This applies, for example, to blasting in open areas with good visibility.

10.2 Tools for heat shrinking safety fuses may only be used or supplied for use when they are to be used for that purpose and are of a recognised make.

10.3 The detonator must be attached via heat shrinking on the safety fuse with such care that ignition can be done safely.

10.4 Safety fuses must be of such length (burning time) that time is given to light it and take cover. The safety fuse must be at least 1 metre long and reach at least 0.2 metres outside the borehole opening or outside the cover. This provision does not apply to blasting with black powder. See section 10.5.

10.5 The safety fuse must reach at least 0.5 metres outside the borehole opening or outside the cover when blasting with black powder.

11. Electric detonators

11.1 Electric detonators can ignite unintentionally by:

- Electrical leakage current in the soil and installations
- Lightning
- Static electricity
- Induction from live cables and wires
- Electromagnetic radiation from radio transmitters, mobile phones, etc.
- Electric welding.

11.2 When using electric detonators, there are a number of conditions to focus on:

- Electrical properties of various types and makes of electric detonators
- Safety distance from electromagnetic radiation
- Equipment for the control and ignition of electric detonators.

Electric detonators can be divided into different types, groups, and classes, as shown in Table 2 below.

Table 2: Electrical properties vary, and the detonators can be categoried as follows:

Type: **Group:** **Class:**	**A** **Class 1**	 **Group 1** **Class 1**	**U** **Group 1a** **Class 2**	**VA** **Group 2** **Class 3**	**HU** **Group 3** **Class 4**
Properties					
Resistance **R i Ω**	**1–5**	**1–5**	**0.6–3.5**	**3.3–3.9**	**0.5–1.0**
Ignition impulse **K_{tu} in mJ/Ω** **$K_{tø}$ in mJ/Ω**	 **0.8** **3**	 **2.5** **5.5**	 **8.0** **16**	 **80** **140**	 **1100** **2500**
Ignition current **I_{tu} in A** **I_k in A**	 **0.18** **0.8**	 **0.28** **1.1**	 **0.45** **1.5**	 **1.3** **3.5**	 **4** **25**
Tension **U_{tu} in Volt**	 **0.2**	 **0.3**	 **0.3**	 **4.3**	 **2.0**

Explanation of "properties" as shown in Table 2

- *The resistance of the detonator in filaments and wires is named R and is measured in Ω (ohm).*
- *Lower limit of ignition impulse, which is named K_{tu} and is measured in mJ/Ω (milli-joules per ohm) and is the minimum ignition impulse for the ignition of one detonator.*
- *Lower limit of ignition current, which is named I_{tu} and measured in A (ampere) and is the minimum ignition current for the ignition of one detonator.*
- *Upper limit of ignition impulse, which is named $K_{tø}$ and is measured in mJ/Ω and is the ignition impulse for the safe ignition of detonators in series.*
- *The minimum ignition voltage, named U_{tu}, is measured in V (volts) and is the minimum voltage for the ignition of one detonator.*
- *The ignition current in a series is named I_k, which is the ignition current for the safe ignition of detonators in series.*

11.3 The electromagnetic radiation from power lines, live cables, substations, radars, and radio transmitters must be investigated prior to the possible use of electric detonators. If in doubt, the cable owner must be asked.

11.4 Detonator wires, single-core cables, and ignition cables must be placed at a safe distance from power lines, live cables, substations, radars, radio transmitters, and the like,

as well as from work involving electric welding or flame cutters. For safety distances, see tables in Annex II.

11.5 Ground fault means the possibility of the current running into the ground and thus disconnecting parts of the ignition system. Ground faults can occur, for example:

- In boreholes that are charged several days before ignition
- In boreholes in heavily cracked materials where there is a risk of insulation damage
- When blasting under water or at other blasts in a humid environment
- At blasts with covering
- When blasting in ores with high electrical conductivity
- When charging with ANFO explosives.

11.6 When the risk of ground faults is high, either electric detonators with reinforced insulation, shock-tube detonators, or electronic detonators must be used.

11.7 It is important to check the ground fault resistance of the ignition system with an insulation meter. The risk of detonation failure because of ground faults is usually small when the ground fault resistance is greater than 4 times the resistance of the ignition system or at least 400 ohm.

11.8 Electric detonators should not be used when charging is carried out over several working days or there is a risk of thunder and lightning, induction, radio and radar irradiance, and welding closer than 30 metres.

11.9 To avoid wire breakage, short circuits, and accidental contact with electrical conductors or the ground, the cable jointing of the ignition system must be carried out correctly. Single-core cable for connection between detonators and ignition cable may be used only once.

11.10 Detonator wires must not have joints inside the borehole, as the wires may be damaged during the charging work.

11.11 Ignition cables must not be placed unnecessarily in water or in places where they may be damaged. Short circuit or ground fault carries the risk of failed detonations.

11.12 Only ignition cables intended for this purpose may be used. No other type of electric detonator shall be used.

11.13 In the case of electric ignition near live high-current wires, the ignition cable must be secured so it cannot get into contact with the wires.

11.14 Resistance metres, insulation meters, or other testing and electrical ignition appliances, lightning alerts, ignition cables, and single-core cables may be used or supplied for use only if they are intended for that purpose and are of a recognized make.

11.15 Electric igniters, devices for controlling electric detonators, and lightning alerts may be repaired only by persons with knowledge and experience of the electrical, mechanical, and safety requirements applicable to such appliances and instruments.

11.16 The capacity of the ignition apparatus must be adapted to the ignition current and energy requirements of the ignition system.

11.17 Electric detonators in the same ignition system must belong to the same class and make and must not be mixed.

11.18 Electric ignition system which is ready for ignition must be checked. However, single charges (single shots) may be switched on without prior checking.

11.19 Failure to ignite electric detonators can occur under both over- and underloading the igniter.

11.20 The following must be checked:

- The insulation and resistance of the ignition cable
- The separation of the ends of the cable. On the end of the cable to be connected to the igniter, the wiring ends must be isolated from each other and separated from ground and electrically conductive materials
- The detonator series resistance
- The resistance of parallel-coupled series. It is important that the resistance is equal and that the difference is not more than +/-5%
- Risk of ground fault. It is important for safe ignition that the ground fault resistance is greater than 4 times the resistance of the ignition system or at least 400 Ω
- The total resistance of the ignition system.

12. Shock-tube detonators

12.1 Shock-tube detonators which are not electric, may be used.

13. Electronic detonators

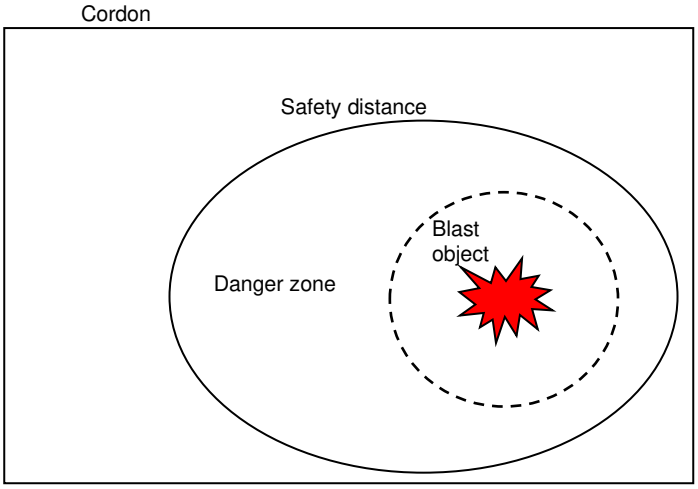
13.1 Do not mix different electronic ignition systems and makes.

14. Safety distances

The danger zone is the area where there is an actual danger to persons.

The safety distance is the periphery surrounding the danger zone, which is determined on the basis of the shotfirer's assessment of the effects of the detonation and covering of vulnerable objects, cf. below.

Barriers run along natural boundaries such as fences, roads, etc., which makes it easy to ensure that no one is within the safety distance. The barrier is often made larger to ensure that people are not exposed to, for example, dust. The area within the barrier and outside the safety distance is called the cordon area (added in figure).



14.1 A normal blast with drilled charging can theoretically reach as far as indicated in Table 3.

Table 3: Theoretical reach at normal blasting without covering with drilled charging.[2]

Borehole diameter	Reach in metres
25 mm	260 metres
51 mm	410 metres
64 mm	480 metres
76 mm	600 metres
102 mm	700 metres

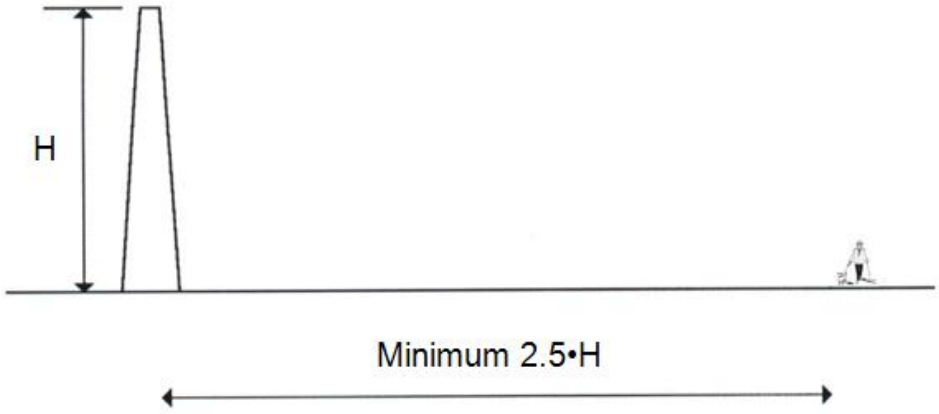
[2] Freddy Larsen, Jan Kristiansen, Tom Richard Olsen, Sigbjørn Lian, Ståle Nilsen, 2003 (Sep), *Sikker sprengning i dagen*, Norsk Forening for Fjellsprengningsteknikk, (downloaded from https://nff.no/wp-content/uploads/sites/2/2020/04/Teknisk-rapport-nr-3.pdf, 2023.01.06).

14.2 Blasting with charging placed externally can lead to explosion fragments scattering, depending on the shape, size, and location of the charging.

14.3 Blasting on iron and steel can result in a reach of up to 1,000 metres, and if the explosive is placed in iron and steel, the reach can reach up to 1,500 metres. For blasting steel, shaped charges can be used. Depending on the type of charge, their location, etc., the safety distance can be significantly reduced.

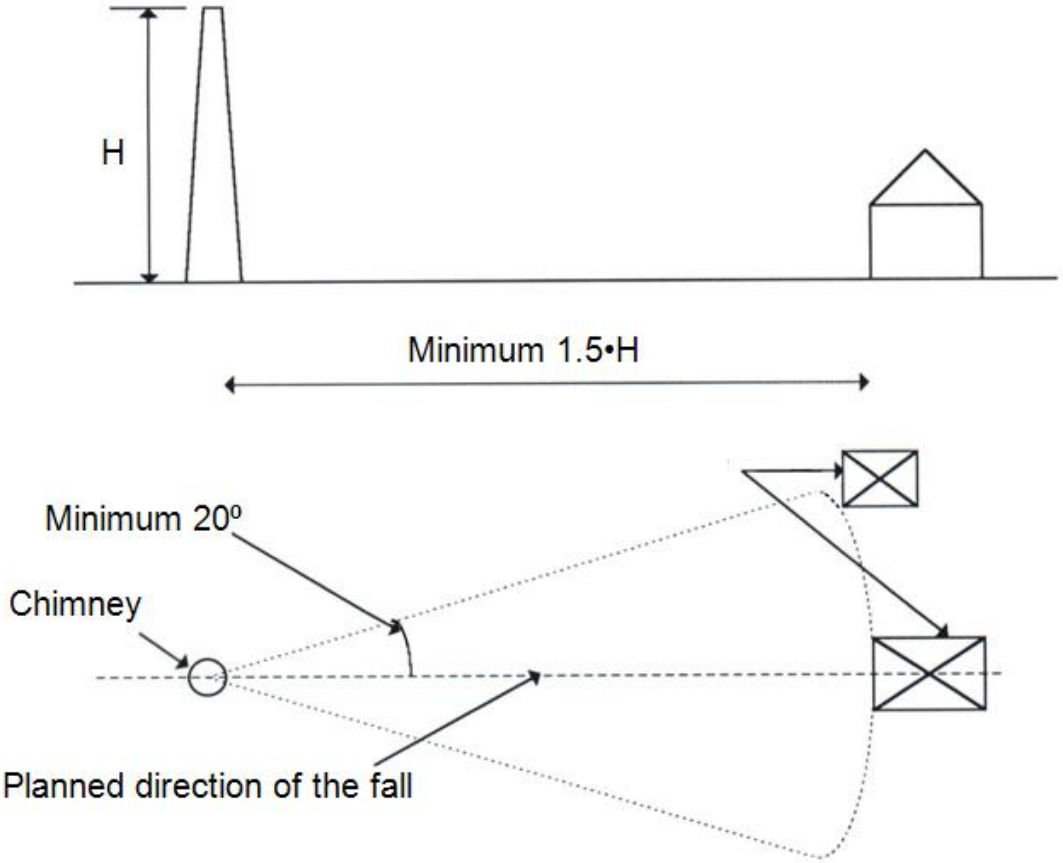
14.4 Persons responsible for detonation or other special tasks may, with the consent of the shotfirer, seek cover within the safety distance. The cover must be effective and protect against fragments from the blast.

14.5 In the case of demolition of buildings and structures, in addition to the safety distance with regard to fragment scatter, a safety distance must also be established with regard to structural parts falling. The safety distance is determined by the height and type of construction and the nature of the base. When a construction hits the ground, material on the ground may scatter, ricochets from the blast site, bolts and other parts that come loose, etc. As a general rule, the safety distance to persons without protection should be set at 2.5 times the height of the structure.



Safety distance in the direction of the fall to unprotected persons/bystanders as a result of the impact of the chimney on dry ground.

14.6 The safety distance to buildings can be significantly less than to people.



Safety distance to neighbouring buildings due to the impact of the chimney on dry ground. It should be noted that it may be necessary to protect windows and facades with wooden boards or suspended fabric covers.

If the ground is soft and there is a risk of mud, the above distances must be increased. In the case of measures in the form of ramparts or other protection, wire pulling, etc. the above distances can be reduced.

14.7 Covering the blast object to intercept fragments, etc. (see section 15) can reduce the safety distance considerably, e.g. a building pillar can be effectively covered and the safety distance can come down to 5 metres.

15. Covering

15.1 If scattering can cause damage, the detonation object must be covered. The cover must be of sufficient size and strength, and it must be positioned with consideration for the contours of the blast, cracks, and the like, as well as the expected direction of scatter.

15.2 At detonations, it is important that covers and protective measures are adapted to the task at hand and the risk of damage. A distinction is made between primary covering and secondary covering.

15.3 Primary covering is used directly on top of the blast object and may consist of heavy blasting mats made of cut-up lorry tires, 0.5–1.0 metre stone-free sand or the like, possibly combined with light blasting blankets/mats.

15.4 Secondary covering is used to protect objects at risk of damage and may consist of wooden boards and light blasting carpets/mats attached to facades, e.g. outside windows and doors.

15.5 The shotfirer is responsible for safety, including the use of covering and determining safety distances to persons and threatened neighbouring buildings, installations, roads, etc.

16. Evacuation, monitoring, warning, and firing

16.1 On the site, there must be rules for evacuation, monitoring, and warning, as well as for igniting the charging.

16.2 Persons may only be within the danger zone with the agreement of the shotfirer and they must be under cover during detonation. The warning must be carried out so everyone in the danger zone is alerted before blasting is initiated.

16.3 At blasting operations within residential areas, the shotfirer must, once warning has been given, ensure that the signal given is heard and recognised by all those in the danger zone and in its vicinity. In special cases, warning notices can be placed in stairwells, etc., with information about the significance of the signals and with the recommendation not to stand by windows and doors facing the blast site.

16.4 In Denmark, the following warning is given:

- Pre-warning is initiated 1–2 minutes before the blast, which is announced with a long siren blare
- The blast is initiated immediately after 2 short blares
- The blast is complete when it is safe to move through the danger zone again. Once completed, 3 short blares are given.

16.5 In Greenland, the following warning is given:

- Pre-warning is given approximately 90 seconds before detonation, which is announced with a siren blare of no less than 5–6 seconds long
- The blast is warned 20–30 seconds before initiation, which is announced by a continuous blare, which continues until any danger of entering the danger zone has ceased.

16.6 Signals or signalling devices that cannot be confused with fire alarms must be used.

16.7 As a substitute for the blaring sound, an oral warning may be given within a strictly limited area when everyone has been sent under cover:

1. The shotfirer announces the initiation of the blast with the words, “Her sprænges”.
2. After that, “Tænd”.
3. When the safety fuse has been ignited, the person(s) who has/have ignited it shouts, “Her er tændt!”

17. Blasting in hot areas and masses

17.1 Blasting in furnaces in operation requires special considerations.

- Information about the general condition of the furnace is obtained prior to the start of the work.
- The plant's health and safety plan must be reviewed.
- Persons in the boiler building must be informed that blasting work is in progress.
- Access routes must be free so quick evacuations are possible.
- When blasting in furnaces, there is a risk of items, such as bits of the ramrod or other aids used, or of slag and dust scattering.
- Due to the risk of scattering and high radiation heat, everyone who is within the danger zone must wear suitable protective equipment in the form of:
  - Helmet with visor
  - Heat-protective clothing
  - Protective gloves.

  Protective equipment must be able to withstand the temperatures by the furnace hatches.
- Explosives and detonators that are not packed can only withstand the heat of the oven for a few seconds. The explosive will begin to burn and when the heat reaches the detonator inside, it will detonate.
- Explosives and detonators can be packed or otherwise kept at a low temperature and can thus last longer inside the furnace.
- Explosives and detonators dropped inside the furnace usually pose no hazards or risks, as the explosive burns away very quickly and the detonator will detonate.
- Explosives and detonators dropped in the ash transport systems must be assessed and, if necessary, the transport system must be stopped and the plant's personnel sent away and replaced by blast-trained personnel before the system is restarted.
- Persons detonating in furnaces must be thoroughly trained in the procedure for inserting explosives and detonators and for the subsequent ignition.

18. Underwater blasting

18.1 For blasting underwater, please refer to the rules of the Danish Maritime Authority. Reference is made to safety distances as specified in Annex III. In general, in ports, people must never be in the water when blasting is to take place.

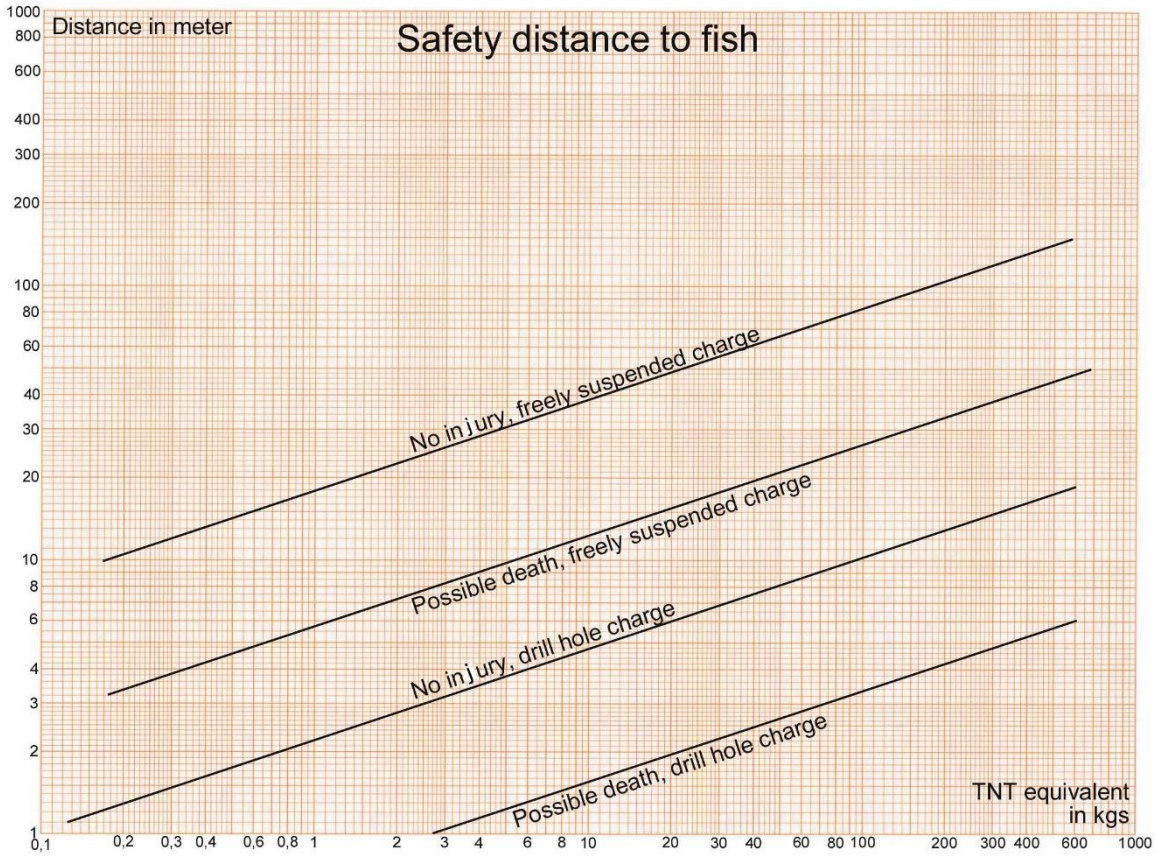
18.2 In the event of an underwater explosion, no person shall be in the water within the safety distance referred to in Annex III.

18.3 Safety distances to ships:

Warships	$R=12\times\sqrt{L}$
Merchant	$R=24\times\sqrt{L}$
Bulkcarriers	$R=48\times\sqrt{L}$

R in metres
L in kg

18.4 Safety distances to fish:



Safety distance to fish. Y-axis: Distance in metres, X-axis: Equivalent TNT in kg.
No injury, freely suspended charge
Possible death, freely suspended charge
No injury, drill hole charge
Possible death, drill hole charge

18.5 Safety distances to other mammals in the water:

Aarhus University[3] has set the limit at 35 kPa·ms (35 Pa·s) for no damage to marine mammals.

19. Return to the blasting area

19.1 After the area is adequately ventilated for hazardous gases, the shotfirer must examine the result of the blasting. Among other things, it must be examined whether there are any failed detonations, which are immediately marked and then rendered harmless as soon as possible.

19.2 Closure of the danger zone must be maintained as long as there is a risk of injury due to delayed detonations, hazardous gases, or the like. The barrier may not be removed until the shotfirer has established that the blast has proceeded as planned and has released the area.

19.3 The detonation object and the immediate surroundings must be sealed off until the site has been cleaned up and there is no danger of injury.

19.4 If the area cannot be examined immediately after blasting, the area must be clearly marked with red and white tape and signs saying “Sprængningsarbejde pågår”. The tape may not be removed until the area has been released for another purpose.

19.5 Before using cutting torches in an area where explosives have been used, flammable materials must be cleared at a distance of at least 2 metres from the cutting.

19.6 In the case of blasting in tunnels, deep shafts, and other enclosed spaces where natural air circulation is prevented, special measures must always be taken to ventilate the area effectively, e.g. ventilating the bottom of the shaft.

19.7 The detonation of explosives produces toxic gases, primarily carbon monoxide (CO) and nitrous gases (NOx).

19.8 Carbon monoxide cannot be seen, smelled, or tasted. If you are exposed to high concentrations of carbon monoxide, unconsciousness will quickly, and without warning, set in, and already after a short time, death will occur.

19.9 Nitrous gases are visible and have a yellowish-brown colour and a pungent stinky odour and are fatal at prolonged exposure.

[3] Tougaard, Jakob et al, 2013 (21. marts), *Choktest af fregatten PETER WILLEMOES*, Notat fra DCE Århus Universitet.

19.10 If there is a risk of the presence of carbon monoxide and nitrous gases in enclosed spaces, you must be equipped with:
- An appropriate gas-measuring instrument with an audible alarm, and
- External fresh-air supply (full mask + tank(s)).

19.11 In any case, the first person entering the space must be secured with a safety line so they can be rescued if they lose consciousness, without exposing the helpers to the same risk.

19.12 Rescue personnel must wear appropriate protective equipment.

20. Destruction of explosives

20.1 Failed detonators may be destroyed only by the responsible shotfirer and under his direction.

20.2 Detonators that have failed must be blown up, for example by dumping the failed detonator(s) into a borehole charged with explosives.

20.3 Detonating cord and black powder must be blown up.

20.4 Smaller amounts of explosives (< 5 kg) and packaging which has contained explosives may be burned on an open fire in an open field/area. If the same field/area is to be used for several burnings, 24 hours must pass between burnings.

20.5 For quantities greater than 5 kg, contact the distributor of the explosive.

20.6 Burning in wood-burning stoves, boilers, steel barrels, or the like is strictly prohibited.

Annex I

Overview of applicable provisions, instructions, and references.

Provisions:

- Provision of the Weapons and Explosives Act
- Provision on Explosives
- Provision of the safe execution of diving work
- Provision of the Working Environment Act
- Provision of the Working Environment Act in Greenland
- Provision of the Building and construction work
- Provision on the transport of dangerous goods by road
- Government of Greenland's Provision on Explosives

Please refer to the Internet to download the latest editions.

www.at.dk
www.retsinfo.dk
www.lovgivning.gl

Instructions:

- Instructions and regulations from suppliers of explosives and detonators
- DSF instruction no. 1: Vibration Effects on Buildings, Plants, and Installations as a Result of Blasting Work
- DSF instruction no. 2: Careful Blasting
- DSF instruction no. 3: Safety instructions in blasting work
- DSF instruction no. 4: Blasting Certificate
- DSF instruction no. 5: Explosion Formulas and Tables
- DSF instruction no. 6: Safety Control in Blasting Operations.
- Industry guidance on accident prevention after blasting work

Annex II

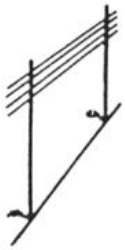
Safety distances for electric and electronic detonators

Distances for classes 1, 3, and 4 come from Norway,[4] and for class 2, distances are from Sweden.[5] The Norwegian instructions are more comprehensive and conservative than the Swedish instructions. The following follows the Norwegian conservative approach.

Tension (kV)	Horizontal distance to overhead power lines (m)			Distance to ground cable (m)		
	Class 1	Class 2	Classes 3 and 4	Class 1	Class 2	Classes 3 and 4
0.4–6	20	5	5	2	2	2
7–12	50	22	5	3	3	2
13–24	70	40	5	6	6	2
25–52	100	55	6	10	10	3
53–72.5	200	70	6	16	16	3
72.6–123	200	85	10	16	16	10
124–245	200	110	12	16	16	16
> 245	200	180	16	16	16	16

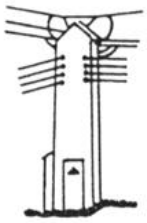
Class 2 detonators are, for example, Rock*Star II or Dynadet-C2.
Class 3 and 4 detonators are, for example, Rock*Star III Omega or Dynadet-C3-25ms.
(Dynadet electric detonators are out of production in 2022, but may be found available in stock).

[4] Orica Norway AS, 2018, Produktkatalog side 99, Orica Norway AS, downloaded from https://indd.adobe.com/view/79c6001c-2341-44cd-871c-fec6fcf1367b 2023.01.09.
[5] Arbetsmiljöverket, AFS 2007:1, 2019 (14. januar), *Sprängarbete, Arbetsmiljöverkets föreskrifter om sprängarbete samt allmänna råd om tillämpningen av föreskrifterna*. https://www.av.se/globalassets/filer/publikationer/foreskrifter/sprangarbete-foreskrifter-afs2007-1.pdf (downloaded 2023.01.06).



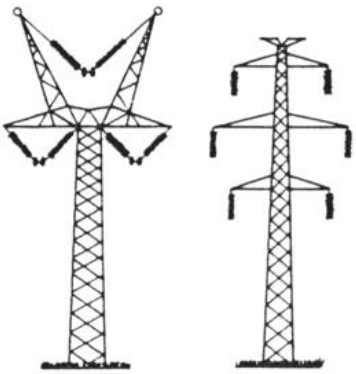
Low voltage!
These masts are along the road, with wires that supply 220–380 volt to the consumers.

High voltage!
This type of mast carry wires with 10 kilovolts from the substation to the transformers.



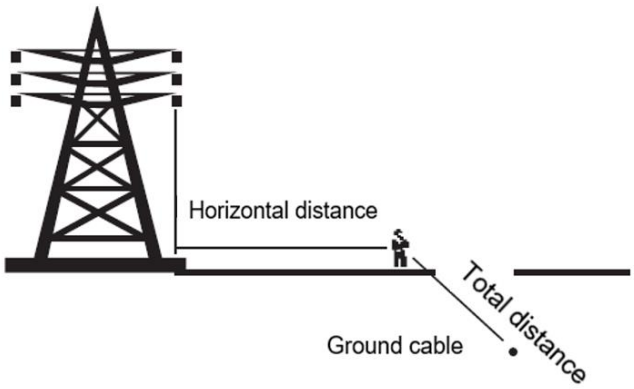
High voltage!
Transformers are across the country and receive 10 kilovolt, which is transformed to 220–280 volt (low voltage).

High voltage!
These types of masts carry wires with 50–400 kilovolt from the power plants to the substations.



High voltage!
Both of these masts carry wires with 132–00 kilovolt from power plants to the substations.

The distances are calculated as horizontal distances perpendicular to the wire from a point vertically below the nearest line or power pole, except for ground cables where the distances are total distances (shortest possible distances).



In underground charging work, e.g. in tunnels and mountains, the distances are calculated as total distances.

The risk of accidental ignition by estimation, induction, or potential differences can be reduced by, for example:

- Placing ignition wires on a dry surface
- Avoiding pulling ignition wires parallel to live wires and avoiding looping ignition wires
- Giving ignition wires extra insulation, e.g. by protecting the cable with rubber tubes where it crosses live wires
- Preventing ignition wires (double-core and single-core) as well as detonator wires from making conductive contact with ground.

With regard to the risk of accidental ignition as a result of potential differences, the conductors in ignition wires and detonator should not come into contact with the ground within a distance of 50 metres from power lines. It is very important that joints are properly protected.

By electric welding near the blasting area, the welding system can build up an electromagnetic field. **Safety distance to welding sites is 30 metres everywhere.**

The risk of accidental ignition from welding systems is reduced by:

- The ignition system being well insulated from the ground and other conductive objects
- The welding cables being the same length and having error-free insulation
- The earth lead from the welding unit being connected to the workpiece as close as possible to the welding site.

Safety distances to radio transmitters are shown in tables below.
In vehicles with radio transmitters or mobile phones, electric detonators may only be transported when positioned so that they cannot be ignited by radio signals. Mobile phones cannot suddenly ignite class 2, 3, and 4 electric detonators when these are in the original packaging.

Safety distance in metres to radio transmitters when blasting above ground

	Electric detonators			
	Group 1 Class 1	Group 1a Class 2	Group 2 Class 3	Group 3 Class 4
Transmitters underground *)	Distance in metres			
1. No matter frequency, less than 5 W	2	1	0.5	0.5
2. Frequency above 26 MHz, 5–110 W	2.5	1	0.5	0.5
3. - do - , 110–500 W	30	20	10	5
4. - do - , above 500 W	80	50	30	10
5. Frequency above 1 GHz, 500–1000 kW	300	200	150	100
6. Frequency below 26 MHz, 5–110 W	100	50	10	5
7. - do - , 110–500 W	150	120	80	30
8. - do - , 0.5–2.5 kW	250	150	100	50
9. - do - , 2.5–10 kW	500	300	170	80

*) For frequencies up to 70 MHz, the same distances apply as for above-ground blasting.[6]

[6] Arbetsmiljöverket, AFS 2007:1, 2019 (14. januar), *Sprängarbete, Arbetsmiljöverkets föreskrifter om sprängarbete samt allmänna råd om tillämpningen av föreskrifterna*. https://www.av.se/globalassets/filer/publikationer/foreskrifter/sprangarbete-foreskrifter-afs2007-1.pdf (downloaded 2023.01.06).

The use of electric detonators closer than 2 metres from the nearest road is not recommended.

Guidance:

Above-ground transmitters cf. 1–9 in the table above generally constitute the following types:

1. *Hand-held radio transmitters and mobile phones (e.g. remote control for crane and other equipment).*
2. *Mobile radios from e.g. the police, taxis, GSM radios, and mobile amateur radio transmitters.*
3. *Stationary amateur radio transmitters, close-range radio transmitters.*
4. *Stationary, civilian FM and TV transmitters and GSM transmitters.*
5. *Stationary amateur radio transmitters, vessel radio transmitters, radio beacons.*
6. *Stationary amateur radio transmitters, vessel radio transmitters, radio beacons.*
7. *Vessel radio transmitters.*
8. *Coastal radio transmitters* (being phased out and dismantled).
9. *Radar systems for aircraft traffic control.*

VHF is short for “Very High Frequencey” and ranges between 30 and 300 MHz.

LF (longwave frequency) is between 30 and 300 kHz, MF (medium-wave) is between 300 and 3,000 kHz, and HF (shortwave) is between 3 and 30 MHz.

The radar is between 1 and 110 GHz.

Safety distance in metres to radio transmitters in case of detonation underground***)**

	Electric detonators			
	Group 1 Class 1	Group 1a Class 2	Group 2 Class 3	Group 3 Class 4
	Distance in metres			
Frequency 70–140 MHz, below 5 W	6	4	2	0.5
- do - , 6–10 W	9	5	3	1
- do - , 11–25 W	14	8	5	2
- do - , 26–100 W	29	15	10	4
Frequency 140–400 MHz, below 10 W	5	3	0.5	0.5
- do - , 11–25 W	8	4	2	0.5
- do - , 26–100 W	16	8	5	2
Frequency above 400 MHz, below 25 W	3	2	0.5	0.5
- do - , 26–100 W	7	4	2	1

*) For frequencies up to 70 MHz, the same distances apply as for above-ground blasting

On sites where electric detonators are used, it is important to pay attention to stationary or moving radio transmitters. For a radio transmitter to be effective, it must have a good and often visible antenna, which can be an advantage when locating the transmitter.

Information about both radio and radar transmitters can be obtained from the Danish Defence Operations Centre (Lyngby Radio) and in Greenland, from Tusass A/S (formerly Tele Greenland A/S).

The use of electric detonators closer than 2 metres from the nearest road is not recommended.

All use of electrical machinery along with electric ignition systems is strongly discouraged.[7]

Electronic detonators – safety distances to electrical energy sources

In general, the following safety distances are recommended for radio transmitters:[8]

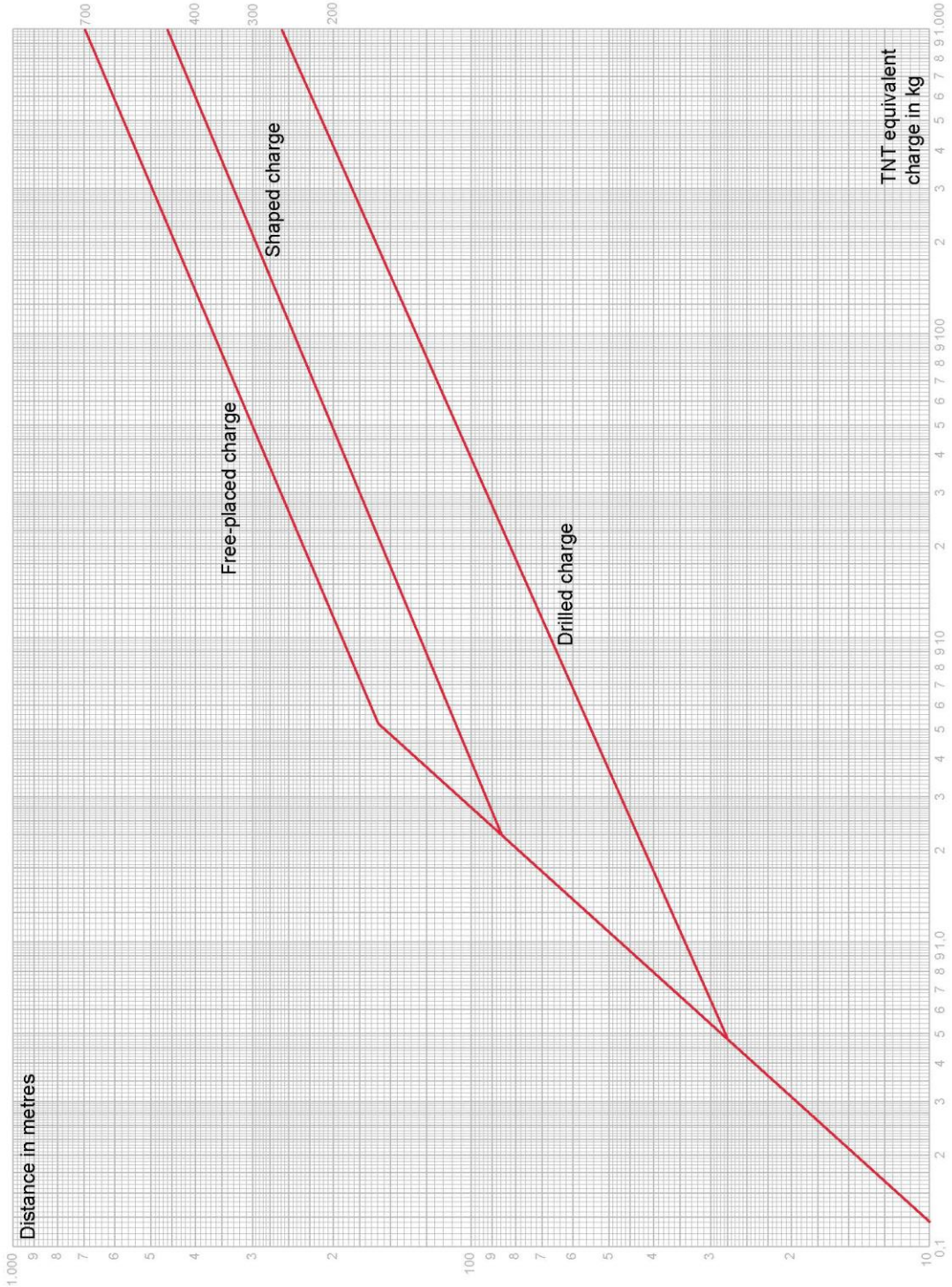
- 1 metre for mobile phones and mobile GPStransmitters (<=25 W).
- Wireless data transmitters (<= 100 mW), such as Wi-Fi and Bluetooth, have no safety distance to electronic detonators.

[7] Lorentzen, Morten, 2022 (11–12 maj), *Elektriske maskiner og håndtering og bruk av sprengstoff*, https://nff.no/wp-content/uploads/sites/2/2021/02/11-Lorentzen-.pdf (downloaded 2023.01.09).

[8] ORICA EBS Technology Team, 2013 (14. juni), *RF Safety Distances for 'Next Generation' Electronic Detonators*, Orica Limited Group, For External Use.

Annex III

Safety distance for persons in water for the detonation of free-placed charge, shaped charge, and drilled charge:



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DANSK SPRÆNGTEKNISK FORENING
c/o SMVdanmark
Islands Brygge 26
DK-2300 København S
Tlf: +45 33 93 20 00
E-mail: DSF@explosives.dk
Web: www.explosives.dk

Medlem af European Federation
of Explosives Engineers